DRAFT

60035

Polymict ANT breccia

1052 grams

Figure 1: Photo of 60035 in upside down configuration (zap pits of bottom). NASA # S72-38302. Cube is one cm.

Introduction

60035 is a fine-grained, clast-rich, polymict breccia made up of clasts of ferroan anorthosite, troctolite, troctolitic anorthosite and noritic anorthosite (Ryder 1980, Warner et al. 1980). There are areas that have melted and recrystallized as well as a "matrix" that is somewhat less feldspathic than the clasts. The meteoritic siderophile content is high. It is apparently a highlands breccia, with no mare component (figure 1).

Apparently the surface of this rock was initially completely covered with a black glass coating (figure 2). The top, eroded surface is now covered with micrometeorite pits and thin brown patina (figure 3).

This sample was originally set aside as a "posterity" sample, to be studied at a later date. It remains poorly characterized 32 years after its arrival on earth.

Petrography

Warner et al. (1980) performed a survey of several thin sections of 60035. They found that it was clastic in nature, with small recrystallized clasts of troctolitic anorthosite and noritic anorthosite making up about 80% of the rock. Additional clasts of cataclastic anorthosite and troctolite were studied (figure 5).

Mineralogical Mode (from Warner et al. 1980)

Lithology	% plagioclase	Plagioclase	Olivine	Orthopyroxene
Cataclastic ferroan anorthosite	99	An96	Fo35	En50
Recrystallized ferroan anor.	95	An97		En52
Troctolite	57	An96	Fo88	En86
Troctolitic anorthosite	84	An95	Fo79	En78
Noritic anorthosite	81	An95	Fo79	En79
Matrix	75	An95	Fo79	En78

Figure 2: Bottom surface of 60035 showing attached black glass. NASA S72-38301. Cube is 1 cm.

Figure 3: Top side of 60035 showing numerous zap pits. NASA # S72-38300. Cube is 1 cm.

A variety of textures are observed, from equigranular, granulitic, poikilitic, annealed cataclastic, to recrystallized. All areas are feldspathic.

Mineralogy

Olivine: Ma and Schmitt (1982) found that an "olivine clast" (troctolite?) was strongly enriched in heavy REE and had a high FeO/MnO ratio (104).

Plagioclase: Plagioclase is uniformly calcic in composition (An_{95}).

Pyroxene: The composition of pyroxene is given in figure 4.

Metal: Warner et al. (1980) found high Ni and Co in numerous metal grains in 60035.

Glass: The black glass found attached to the surface of 60035 has been studied by See et al. (1986) and Morris et al. (1986).

Chemistry

Ma and Schmitt (1982) analyzed the white interior and the black glass and found high Ir indicating meteoritic contamination throughout (table 1). They found similarity of the white interior with materials from North Ray Crater, while the glass was similar to South Ray Crater !?

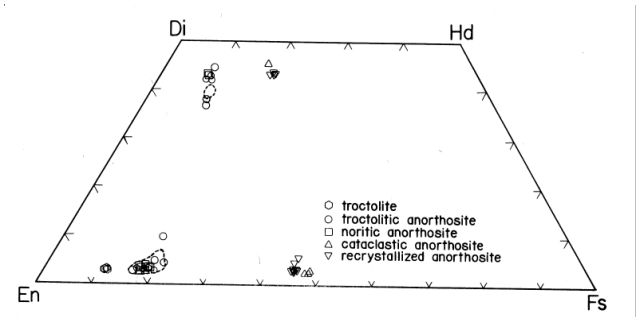

Figure 4: Pyroxene composition of various lithologies in 60035 (figure from Warner et al. 1980).

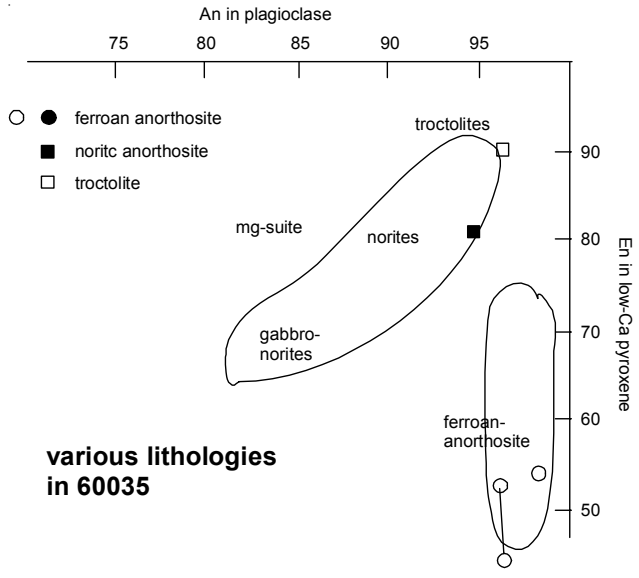

Figure 5: Plagioclase and low-Ca pyroxene diagram (from Warner et al. 1980).

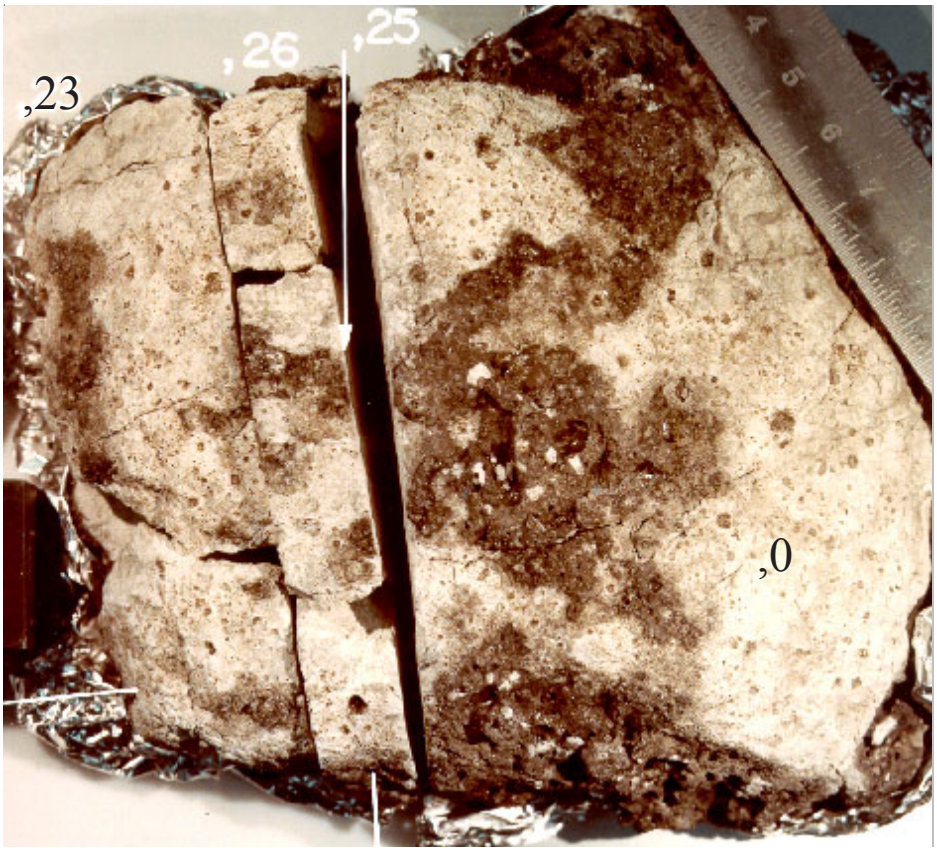

Figure 6: Group photo of 60035 after sawing to create slab. NASA # S80-35183. Scale is in cm.

Figure 7: First saw cut, butt end ,22 and ,23 of 60035. NASA # S80-35176. Scale is in cm.

Figure 8: Second saw cut, butt end ,0 of 60035. NASA # S80-35184. Streaks are from sawblade.

Radiogenic age dating

This sample has not been dated.

Processing

In 1980, a slab was cut through the middle of this large rock (figures 6 and 7). From its appearance, it will prove difficult to break this rock up into its original lithic clasts.

List of Photo #s

S72-38300-38303	color mug shots
S72-40955	showing zap pits
S72-40962	showing zap pits
S80-35179-35183	reassembled parts
S80-35176	saw cuts
S80-35184	saw cuts

Table 1. Chemical composition of 60035.

	glass coat		glass coat		blk glass	interior	interior	
reference	Morris 86		Warner 80		Ma 82 abs	Ma 82	Ma 82	
weight								
SiO2 %	44.31	(b)	44.1	(b)				
TiO2	0.3	(b)	0.29	(b)	0.3	0.2	0.2	(a)
Al2O3	28.31	(b)	29	(b)	27.2	26	25.9	(a)
FeO	5.19	(b)	5.1	(b)	4.9	4	4.3	(a)
MnO			0.04	(b)	0.059	0.053	0.056	(a)
MgO	6.47	(b)	6	(b)	5.5	8.4	8.2	(a)
CaO	15.49	(b)	15.7	(b)	16.3	14.3	14.1	(a)
Na2O	0.31	(b)	0.26	(b)	0.36	0.379	0.413	(a)
K2O	0.08	(b)	0.06	(b)	0.058	0.069	0.064	(a)
P2O5			0.02	(b)				
S %								
sum								
Sc ppm	6.07	(a)			5.5	5.5	5.9	(a)
V					15	21	19	(a)
Cr	696	(a)			691	752	745	(a)
Co	41	(a)			43	18	19	(a)
Ni	438	(a)			630	180	200	(a)
Cu								
Zn								
Ga								
Ge ppb								
As								
Se								
Rb						2		(a)
Sr					190	135	190	(a)
Y								
Zr					130	50	50	(a)
Nb								
Mo								
Ru								
Rh								
Pd ppb								
Ag ppb								
Cd ppb								
In ppb								
Sn ppb								
Sb ppb								
Te ppb								
Cs ppm						0.1	0.1	(a)
Ba	232	(a)			140	40	60	(a)
La	10.04	(a)			8.3	2.8	3	(a)
Ce	24.1	(a)			22	7.2	7.3	(a)
Pr								
Nd					14	4	6	(a)
Sm	4.3	(a)			3.87	1.18	1.33	(a)
Eu	1.2	(a)			0.96	0.84	0.9	(a)
Gd								
Tb	0.88	(a)			0.68			(a)
Dy					4.6	1.9	2.2	(a)
Ho								
Er								
Tm								
Yb	3.04	(a)			2.72	1.22	1.43	(a)
Lu	0.42	(a)			0.37	0.17	0.19	(a)
Hf	3.21	(a)			2.8	1	1.1	(a)
Ta	0.31	(a)			0.4	0.2	0.2	(a)
W ppb								
Re ppb								
Os ppb								
Ir ppb					14	3.8	3.5	(a)
Pt ppb								
Au ppb								
Th ppm	1.33	(a)			1.38	0.75	0.82	(a)
U ppm	0.78	(a)						
technique	*(a) INAA, (b) microprobe*							